House Price Index

RE420: URBAN AND REGIONAL ECONOMICS



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- Imagine we want to say something about the changes in the house price level in general.
- I may want to say that house prices in Madison increased a lot in the recent few years.



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- Imagine we want to say something about the changes in the house price level in general.
- I may want to say that house prices in Madison increased a lot in the recent few years
- Wait.. Am I wrong?

< A Sale Record in Madison, WI, in 2022 >



5 bd | 6 ba | 7,375 sqft 5010 Lake Mendota Dr, Madison, WI 53705

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< A Sale Record in Madison, WI, in 2024 >



4 bd | 2 ba | 1,703 sqft 413 Bordner Drive, Madison, WI 53705



- Complication comes from the fact that the property values (prices) depend on their characteristics
 - e.g., # bathrooms, floor space, etc.
- In other words,
 - Quality of housing for transactions in Madison also varies over time
- We need methods to discuss the overall housing price level, rather than focusing on specific property values.



- How can we measure the general house price level of a location and its changes?
 - This topic is important for anyone related to real estate!
 - Developers/REIT managers/firm managers/mortgage bankers/individual homeowners/..



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House Price Index

- A house price index (HPI) measures the price changes of residential housing as a percentage change from some specific start date (which has an HPI of 100).
- In the US, there are two popular HPIs
 - Federal Housing Finance Agency (FHFA) House Price Index
 - S&P CoreLogic Case-Shiller Home Price Index





Source: FHFA

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S&P CoreLogic Case-Shiller vs. FHFA House Price Indexes (HPI) of U.S. (1995.1.1 ~ 2022.06.01, 2000.1.1=100)

https://fred.stlouisfed.org/series/CSUSHPINSA; https://fred.stlouisfed.org/series/USSTHPI

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- Both are constructed from the same methodologies, called **Repeat-Sales Model**
- Are they exactly the same? No!
 - Index values could vary by a small detail (e.g., sample selection)

House Price Indexes Methodologies



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Popular House Price Index Methodologies

- The Representative Property Method
- Average/Median Price Index Method
- The Hedonic Price Model
- The Repeat-Sales Price Model



The Representative Property Method

- The Representative Property Price Index defines a representative property and collect the price of the property in each period.
- Advantages:
 - Easy and straightforward to understand
 - Requires a small data size.
- Limitations:
 - The representative property may not be comparable across different markets
 - It does not utilize information from other properties
 - The chosen representative property may no longer accurately reflect the housing market.



Average/Median Price Index

- Average or Median Price Index collect the sale price data for all properties transacted during the period.
- Advantage:
 - Easy to calculate and understand
 - Considers all property transactions rather than focusing one
- Limitations:
 - Requires a much larger data collection than Representative Property Method.
 - Average/Median Price Index fails to control for changes in the *quality* or *mix* of properties



- The Hedonic House Price Index measures property values by accounting for various characteristics that affect price, such as size, location, and amenities.
- A Standard Hedonic Model (review Lecture Note 7 for more details!)

$$\ln P_{it} = \alpha + \beta_1 \ln X_{1i} + \beta_2 X_{2i} + \sum_{t=2}^T \gamma_t D_t + \varepsilon_{it}$$

- P_i is transaction price of property *i*, and is expressed in logarithmic form because the housing transactions prices are log-normally distributed;
- X₁ represents any continuously measured property, locational and neighborhood hedonic characteristics (e.g., lot size);
- X₂ represents any discretely measured property, locational and neighborhood hedonic characteristics (e.g., number of bedrooms, presence of garage);
- D_{it} is indicator variables which take value of 1 if property *i* transacted during period *t* and 0 otherwise (year dummy)



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- Specifically, the Hedonic House Price Index utilize the values of γ_t , the coefficient estimates of year dummies
- Changes in the γ_t values reflect annual changes in house price levels after accounting for the heterogeneous characteristics of individual housing units



- Advantages:
 - Measures the house price changes while keeping the constant quality
 - Factors out the quality differences of housing units, separating the pure price change from the change in quality
- Limitations:
 - Data Intensive: Requires extensive data collection and sophisticated statistical techniques.
 - Omitted Variable: Impossible to know all the variables that affect housing prices, and omitting the key variables will affect the estimated values for γ_t .



The Repeat-Sales HPI Model

- The Repeat-Sales House Price Index model extends the hedonic house price index model by utilizing the two paired transaction observations on the same property
- The Hedonic Model

$$\ln P_{it} = \alpha + \beta_1 \ln X_{1i} + \beta_2 X_{2i} + \gamma_t \tag{1}$$

$$\ln P_{is} = \alpha + \beta_1 \ln X_{1i} + \beta_2 X_{2i} + \gamma_s \quad (t \neq s) \tag{1'}$$

• The Repeat-Sales Model: subtract eq. (1') from eq. (1),

$$\ln \frac{P_{it}}{P_{is}} = (\alpha - \alpha) + \beta_1 (\ln X_{1i} - \ln X_{1i}) + \beta_2 (X_{2i} - X_{2i}) + (\gamma_t - \gamma_s)$$
(2)

Since the hedonic characteristics remain unchanged, the first three terms in RHS equals to zero.



The Repeat-Sales HPI Model

• From eq. (2), the repeat-sales model can be simplified to:

$$\ln \frac{P_{it}}{P_{is}} = \gamma_t - \gamma_s$$

- Advantages:
 - Based on the same theoretical consideration as the Hedonic House Price Index
 - Data burden is lower than the Hedonic HPI, because all X_i 's are differenced out
- Limitations:
 - Selection Bias: Rely on properties that sell multiple times
 – these properties may not
 represent the overall market
 - Violation of constant quality assumption (Meese and Wallace, 1991): the same property may experience changes in housing quality



Key Takeaways

- Understand the concept of house price index and its usefulness.
- Understand different approaches to construct the house price index
- Pros and cons of different approaches

Optional Readings:

- Kain, J., Quigley, J. 1970. "Measuring the Value of Housing Quality," *Journal of the American Statistical Association*, 65(330) 532-548.
- Silverstein, J. 2014. "House Price Indexes: Methodology and Revisions", Federal Reserve Bank of Philadelphia.

